STUDY OF CONTRAST ENHANCEMENTTECHNIQUES

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Master of Technology

In

Electronics and Communication Engineering

Specialization: Signal and Image Processing

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CERTIFICATE

This is to certify that the work done in the thesis entitled **Study of Contrast Enhancement Techniques** by **Bogiri Praveen Kumar** is a record of an original research work carried out by him in **National Institute of Technology, Rourkela** under my supervision and guidance during 2014-2015 in partial fulfilment for the award of the degree in Master of Technology in Electronics and communication Engineering with specialization in Signal and Image Processing, National Institute of Technology, Rourkela.

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Declaration

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b. The work has not been submitted to any other institute for any degree or diploma.
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Bogiri Praveen Kumar

28th May, 2015.

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ABSTRACT

One of the most important issues in the image processing is contrast enhancement. The point of picture enhancement is to enhance the impression of data in pictures for human watchers or interpretability, or to offersthe `best' input benefit to the various automated image processing approaches. A digital image processing technique is proposed in order to enhance image contrast without significant noise enhancement. Double threshold segmentation algorithm (DTS) is the main base for the operation of contrast enhancement. DTS divides the image into three effective basic zones such as object zone,transition zone and background zone. DTS delivers two threshold points which can beused for controlling the contrast adjust curve. Fuzzy techniques are a very suitable to manage the elusiveness of this approach efficiently.To signify and process the knowledge of human-being in the form of fuzzy, thefuzzy logic is a potential tool. In recent investigations, many research authors have used fuzzy logic to improvenovel image processing algorithms.

In this work thefuzzy membership function algorithm is used. This algorithm enhances image contrast very effectively.To fuzzify the image information in the spatial domain, Gaussian membership function is used for the enhancement of image color by using three parameters, such as fuzzifier (f_h), intensification parameter (t), and crossover point (μ_c). To implement this approach MATLABR2010a Simulink image processing tool box is used. Simulation results shows that the significant improvement in the quality of image.

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Chapter 1

Introduction

Image enhancement methodsreferred to a collection of different techniques that search forthe improvement of the photographic appearance of an image or for converting the image to a form which is better suitable for the analysis of a machine or a human. In many applications and research areas the enhancement of noisy image data is a big technical problem. Image enhancement approaches can be grouped into three extensive categories such asFrequency domain methods, which are based on the Fourier transformation of an image, spatial domain techniques, which are based on the pixels directly, andFuzzy domain techniques, which comprises the use of knowledge-based systems that are able toimitate the activities of a human expert.The main advantages of spatial based domain techniquesare the lowcomplexity which brings the favours in real time implementations and they are conceptually simple to understand. However,thesemethodscommonly lacks in providing imperceptibilityandadequate robustness requirements. Fuzzy logic is a good measured frame to handle the problem of uncertainty in the image information.

In this work the fuzzy membership function algorithm is used. This algorithm improvesquality of image contrast very efficiently. The intensifier operator will convert the image data into the fuzzy domain and process some morphological operation when the observed data is disturbed by random noise and then by applying this algorithm the good contrasted image is found compare to the original image, preserves the all image data. Significant result are obtained in this work using MATLAB R2010a Simulink image processing tool box is used.

1.1. Digital Image:

Image is known as a 2-D function of light intensity f(x, y), where x and y signifies spatial co-ordinates and the value of ‘f’ at any point is straightproportional to the brightness or grey level of the image at any point. When the intensity and x, y values of f are all fixed and discrete quantities then theimage is called as a digital image.

1.2. Digital Image Processing:

The processing of images by digital computer is referred to the Digital image processing. Digital image consists of a fixed no. of elements, each of them has a intensity value and particular location. These elements are known aspixels. Pixel is usedto denote the elements most widely of a digital image. Digital image processing is done on one image and produces a changed version of that image. Image digitization is a procedure that converts a pictorial form to numerical data.

Let f(x, y) be a new image, where ‘f’ is grey level value and (x, y) are the image co-ordinates. For 8-bit image, ‘f’ can take value from 0 – 255. Where Black isrepresented by 0, White is represented by 255 and all the intermediate values represents darks of Grey.

Spatial domain techniques are processes that work directly on the pixels.Spatial domain process is signified by the expression.

$$g(x,y) = T\left[f(x,y) \right]$$

Where

f(x, y) is original image and ‘T’ is the spatial transformation applied to it to get a new modified image g(x, y).

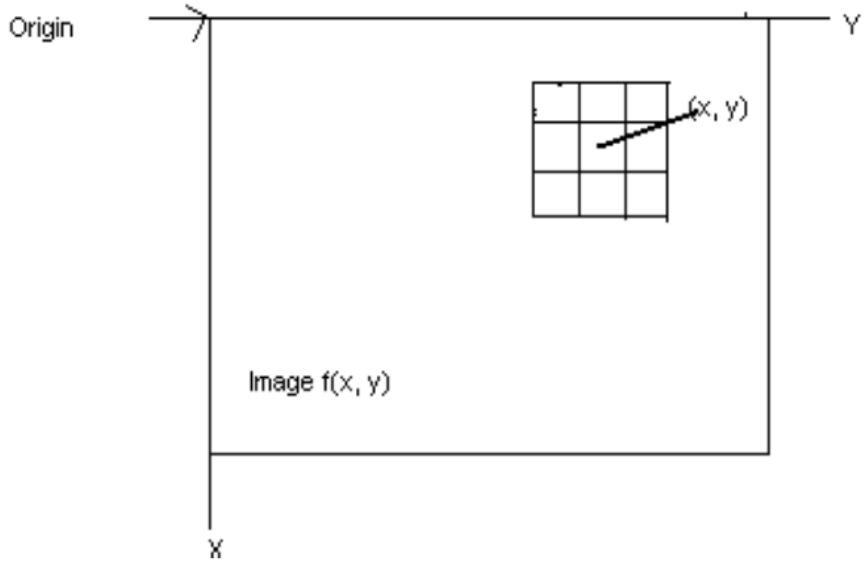


Figure 1.1:3X3 Neighbourhoodof an image about a point (x, y)

1.3. Types of digital image:

Basically three types of digital images are there they are

Grayscale images

Colour images

Binary images

1.3.1. GrayScale Image:

Greyscale digital image is a picture in which the estimation of every pixel is a solitary example that is it conveys just power data. Images of this type, also known as black-and-white, are collectedentirely invariety of grayshades, varying from the lowest intensity to the Highest.Greyscale images are different from one-bit bi-tonal black-and-white images, which in the framework of computer imaging are images with only the double colours, black and white. Greyscale images have countless shades of grey between lowest and highest. These

grey levels compass the full range from dark to white in a progression of extremely steps, usually 256 dissimilar grey levels.Suppose 256 grey levelimage, each white andblack pixel is stored in a single byte (8bits) of memory.

Figure 1.2: Grayscale Image of Lena

1.3.2. Color images:

A color image is comprised of pixels, each of which holds three numbers comparing to the red, green and blue levels of the picture at a specific area. Expecting 256 levels, every shading pixel can be put away in three bytes (24 bits) of memory. Note that for pictures of the same size, a high contrast form will utilize three times less memory than a shading adaptation.

Figure 1.3: Color Image of Lena

1.3.3. Binary images:

Binary images utilize just a solitary bit to speak to every pixel. Since a bit can just exist in two states ON or OFF, every pixel in a twofold picture must be one of two hues, typically dark or white. This neglects to speak to moderate dim levels restrains their convenience in managing applications like photographic pictures.

1.4. Different types of Noises:

There are various noises that may degrade the quality of an image:

Gaussian (Amplifier) Noise

Salt and Pepper Noise

Uniform (Quantization) Noise

1.4.1. Salt and Pepper noise image:

Impulsive commotion or Fat-tail conveyed is here and there called Salt and Pepper clamor. A picture contains salt and pepper clamor can have splendid pixels in dim districts and dim pixels in brilliant areas. This commotion is brought about by quantizers in simple to computerized converter blunders, bit slips in transmission by a channel and so forth. An active noise decrease method for this type of noise is a median filter or a morphological filter.

Figure 1.4: Salt and Pepper Noise Image

1.4.2. Gaussian Noise image:

Gaussiannoise added to images duringattainment. Example radar noise caused by high temperature or/and transmissionor/and poor illumination. Gaussian noise is a foremost part of the “readnoise” of an imageradar, whichis of the steady commotion level in dull territories of the picture. In shading cameras where more intensification is utilized as a part of the blue shading channel than that of green and red channels, In Blue channel therecan be morenoise probability.

Figure 1.5: Gaussian Noise Image

1.5. Application Fields of Digital Image Processing:

Currentlythere is each region of specialized try that is affected somehow by computerized picture preparing. The territory of utilization of computerized picture preparing are varied to the point that some type of association is attractive in endeavoring to catch the broadness of this field. One of the least difficult approaches to build up an essential comprehension of the degree of picture preparing applications is to sort pictures as indicated by their source like visual, X-beam, satellite et cetera. The primary vitality hotspot for pictures being used today is the electromagnetic vitality range. Other imperative wellsprings of vitality incorporate acoustic, ultrasonic, and electronic. Manufactured pictures created by PCs are utilized for displaying and representation.

Fundamental Steps in Digital image processing:

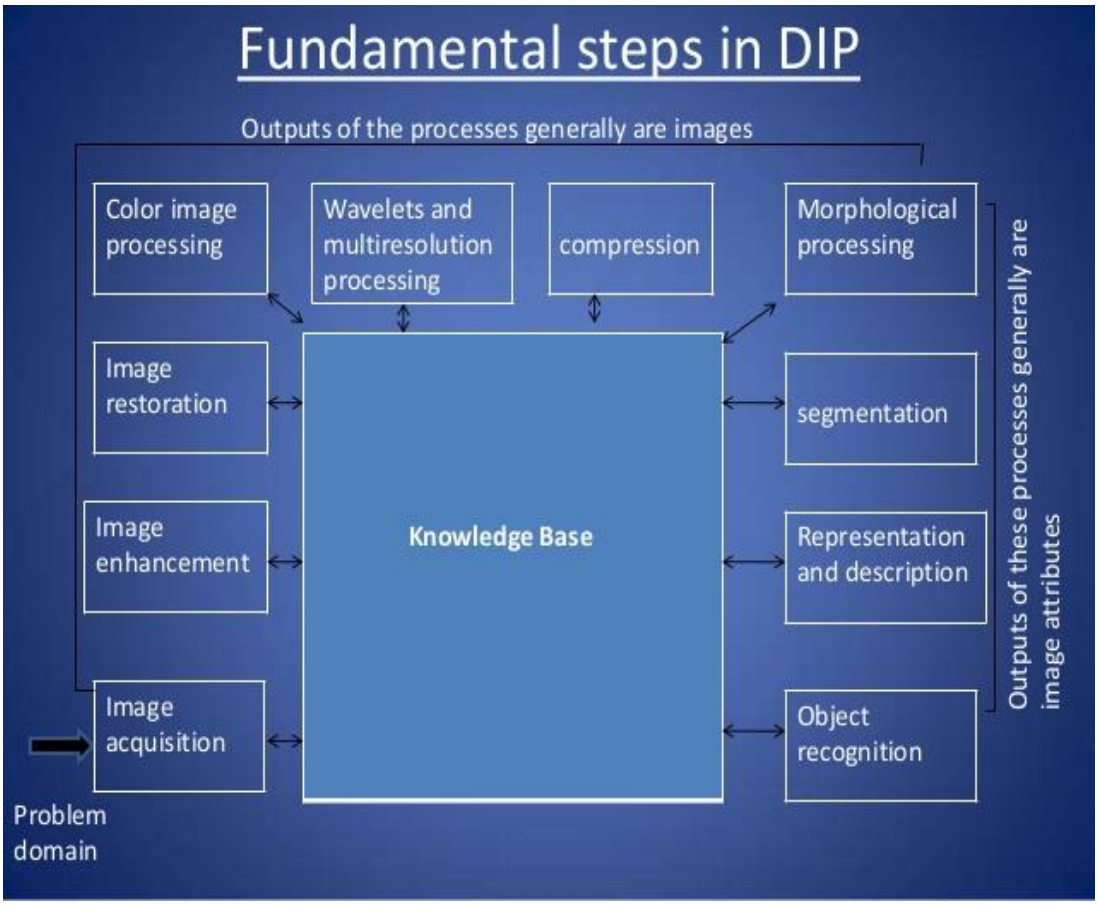


Figure 1.6: Digital Image Processing Fundamental steps

Image acquisition:

Image acquisition is the formerlyproceduretake note of that obtaining could be as basic as being given an image that is now in digital form. By and large, the image obtaining stage includespre-processing, for example, scaling.

Image Enhancement:

Image enhancement is the procedure of controlling an image so that the outcome is suitable than the novel for a particular application. The word particular is vital here, because it launches at the outset that enhancement skills are issue oriented. Therefore, for instance a technique that is very valuable for improving X-ray images may not be the finestmethodology then again improving satellite pictures taken in the infrared band of the electromagnetic range.At the point when a picture is handled for optical elucidation, the viewer is a definitive justice of how fine a specific system functions.

Image Restoration:

Image restoration is aregion that manages the enhancing the presence of an image. However, not at all like improvement which is particular, image restoration is independent, in the sense that restoation methods tend to be based on numerical or probablistic models of picture degradation. Upgrade, then again is in light of human subjective inclinations in regards to what establishes a decent improvement result.

Color image processing:

Color picture processing is a territory has been picking up in significance due to the noteworthy increment in the utilization of advanced pictures over the web.

Wavelets:

Wavelets are the establishment for speaking to pictures in different degrees of determination. It is utilized for picture information pressure and for pyramidal demonstration, in which pictures are subdistributed progressively into littler locales.

Compression:

Compression as the name infers, manages strategies for diminishing the stockpiling needed to spare a picture, or the transfer speed needed to transmit it. Picture pressure is recognizable to most clients of PCs as picture record augmentations, for example, the jpg document augmentation utilized as a part of the Joint Photographic Experts Group (JPEG) picture pressure stock.

Morphological Processing:

Morphological preparing manages instruments for separating picture segments that are valuable in the representation and portrayal of shape. A move from procedures that yield pictures to procedures that yield picture characteristics.

Segmentation:

Image Segmentation is the procedure of parceling a computerized picture into different fragments (sets of pixels otherwise called super pixels), that is division methods segment a picture into its constituent parts or items. The objective of division is to improve or change the representation of a picture into something that is more important and simpler to dissect.

Representation and description:

Representation and portrayal quite often take after the yield of a division stage, which normally is crude pixel information, establishing either the limit of a district or all the focuses in the area itself. Depiction likewise called element determination, manages removing qualities that outcome in approximatelymeasureable data of interest or fundamental for separating one class of articles from another.

Object Recognition:

Recognition is the procedure that allots a name to an article taking into account its descriptors.

1.6. Image Processing:

Image processing is a strategy to change over a picture into computerized frame and perform a few operations on it, so as to get an upgraded picture or to concentrate some helpful data from it. Computerized picture handling is the utilization of PC calculations to perform picture preparing on advanced pictures. It is a sort of sign agreement in which inputs is picture, similar to feature edge or photo and yield may be picture or qualities connected with that picture. As a subcategory or field of advanced sign handling, computerized picture preparing has numerous focal points over simple picture handling. Typically Image handling framework incorporates regarding pictures as two dimensional signs.

Image processing includes basically three steps:

1. Importing the image with digital photography or by visual scanner.
2. Analysing and handling the image which comprises data compression and image enhancement and noticing patterns that are not to human eyes like satellite photographs.
3. Outputs is the last stage in which result can be modified image or report that is in view of imageexamination.

Image processing resolve:

Image processing is distributed into 5 collections. They are:

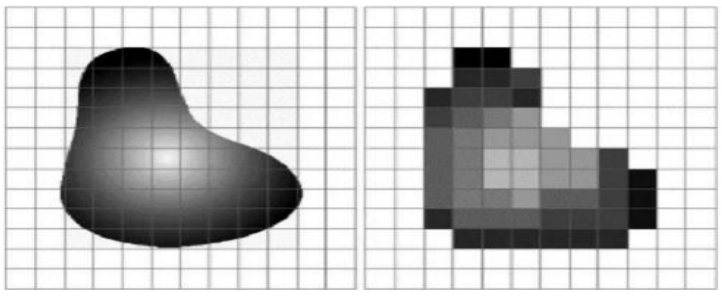
1. Objects that are not visible to observer-Visualization.
2. Improved image is to be created -Image improving and restoration.
3. Image recovery - Seek for the importance of image.
4. Actions various objects in an image - Dimension of pattern.
5. Differentiate the objects in an image - Image Recognition.

Types:

Image processing is divided into Digital image processing and Analog image processing.

Analog image procesing or visual systems of image processing can be utilized for the printed copies like printouts and photographs. Image experts use several fundamentals of elucidation while consuming these visual methods. The image processing is not limited to region that has to be studied but on knowledge of analyst. So examiners apply a mix of individual learning and security information to picture handling.

Digital processing methods help in handling of the digital images by utilizing computers. As raw data from imaging sensors from satellite stage contains insufficiencies. To get over such defects and to get creativity of data, it needs to experience different periods of preparing. The three general stages that a wide range of information need to experience while utilizing computerized strategy are Pre-handling, improvement and presentation, data extraction.



(a) Original Image (b) Pixel Image

1.7. Image Processing Performance:

Image processing can be divided into four groups:

1.7.1. Image Enhancement:

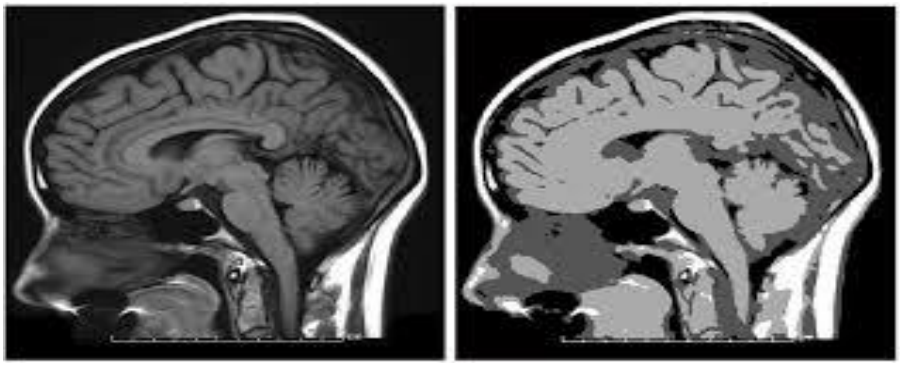
Image enhancement is nothing but getting a clear image. Image enhancement can be preserved as converting an image to another so that the image is to enhanced or to see or machine examination.

(i) (ii)

Figure 1.7: (i) Original Image (ii) Enhancement Image

1.7.2. Image Segmentation:

The procedure of apportioning a computerized picture into different areas (set of pixel) is called picture division. Division of a picture involves the division or partition of the picture into districts of comparative trait.



(i) (ii)

Figure 1.6: (i) Original Image (ii) Segmentation Image

1.7.3. Image Compression:

Image compression name it tells reducing the size in bytes of representation file without corrupting the excellence of image to an improper level. The lessening in file size permits more images to store in a given amount of memory space or disk. It likewise decreases time needed for picture to be sent over web or download from web.

(i) (ii)

Figure 1.7: (i) Original Image (ii) Compression Image

1.7.4. Image Restoration:

Image restoration name it tells minimizing the size in bytes of representation record without corrupting the nature of picture to an inadmissible level. The decrease in record size permits more pictures to store in a given measure of circle or memory space. It likewise decreases time needed for picture to be sent over web or download from web.

1.8. Histogram:

Histogram is nothing but an image signifies the relative frequency of existence of the countless grey levels in an image.

Histogram image can be connived in two ways:

1. In first method, the Y-axis has the no. of pixels in each grey level and the X-axis has gray level.

2. In second method, the Y-axis characterizes the frequency of the occurrence of the graylevel, the X-axis characterizes the gray level.

1.8.1. Histogram Equalization:

Histogram equalization means equal number of pixels in all the gray levels. Here our goal is to spread the dynamic extent, as well as to have parallel pixels in every grey level. It is done through cumulative density function.

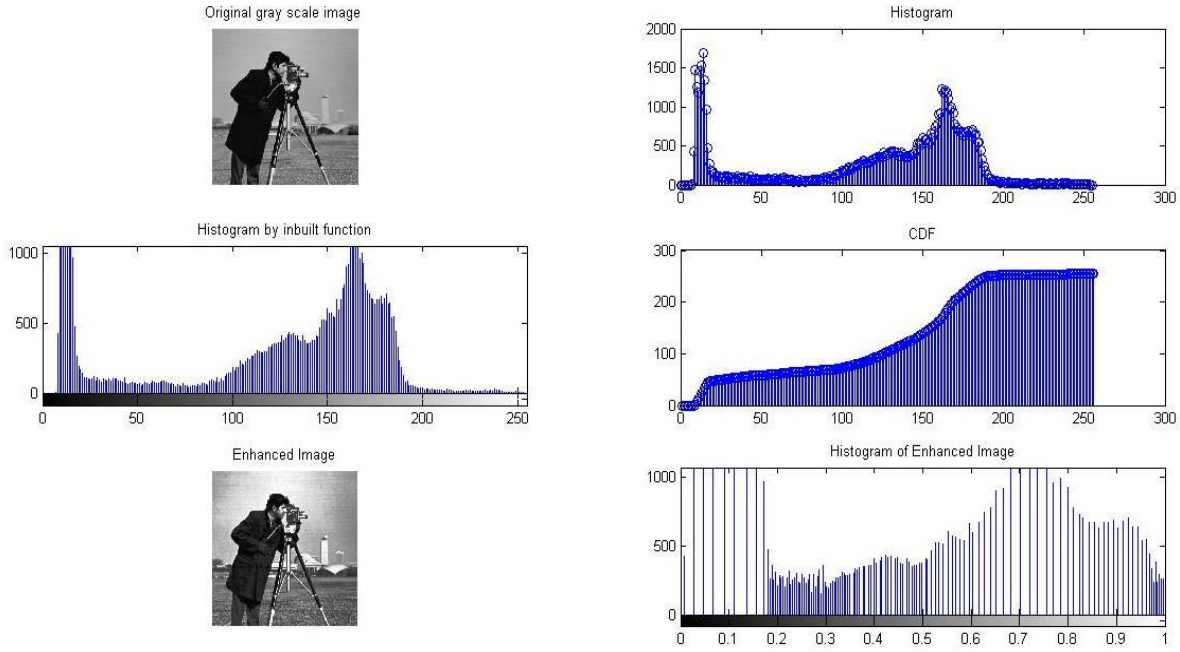


Figure 1.8: Histogram Equalization

Chapter 2

Image Enhancement and Fuzzy Image Processing

2.1. Enhancement:

Image enhancement procedurescomprise of a gathering of strategies that try to enhance the visual presence of a picture or to change over the picture to a structure more qualified for examination by a machine or a human. The rule goal of picture upgrade improvement strategies is to process a picture so that the outcome is more suitable than the first picture for a particular application.

It is regularly used to build the complexity in pictures that are considerably dull or light. Picture upgrade involves operations that enhance the appearance to a human viewer, or operations to change over a picture to an organization more qualified to machine preparing. Picture upgrade alludes to those picture handling operations that enhance the nature of information picture with a specific end goal to beat the shortcoming of the human visual framework.

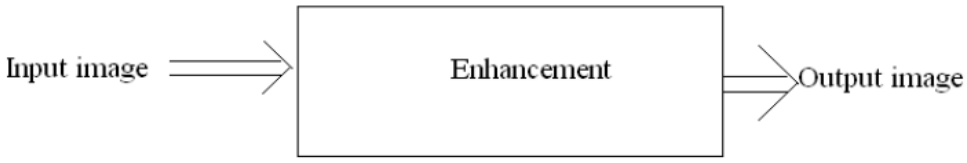


Figure 2.1: Operation of Image Enhancement

Image enhancement methods is divided into three broad classes:

2.1.1. Spatial Domain methods.

2.1.2. Frequency Domain methods

2.1.3. Fuzzy Domain

2.1.1. Spatial Domain methods:

Spatial domain methods whichwork directly on the pixels.Spatial domain system pixel qualities may be changed by that rely on upon the first pixel esteem (neighborhood or point forms). On the other hand, pixel qualities may be joined with or contrasted with others in their quick neighborhood in an assortment of ways.

Suppose f(x, y) be a novel image, wherex, y are the image co-ordinates and f is the gray level value. For example 8-bit image, f has the values from 0 – 255. Where black denotes 0, Whitedenotes 255 and all the intermediate values representsglooms of gray.

The modified image can be shown as

$$g(x,y) = T\left[f(x,y) \right]$$

Here f(x, y) is the original image and T is the transformation applied to it to get a new modified image g(x, y). The worker T is applied at every location (x, y) to yield output g at that place.

Spatial domain enhancement can be done in two ways:

1. Point processing
2. Neighborhood processing

Some of the examples of point processing are digital negative, contrast stretching, Thresholding etc.

Some of the examples of neighbourhood processing are image filtering that is max, min, mean, median etc. these are the order statistical filters.

2.1.2. Frequency domain methods:

Frequency domainworks on Fourier transform of an image.

1. Edges and sharp moves e.g., clamor in a picture contribute essentially to high-recurrence substance of Fourier change.
2. Low recurrence substance in the Fourier change are capable to the general appearance of the picture over smooth zones.

The idea of separating is simpler to envision in the recurrence space. Thusly improvement of picture f(x, y) should be possible in the recurrence area in view of DFT. This is especially helpful in convolution. in the event that the spatial degree of the point spread grouping h(x, y) is expansive then convolution hypothesis.

$$g(x,y) = h(x,y) * f(x,y)$$

g(x, y) is enhanced image.

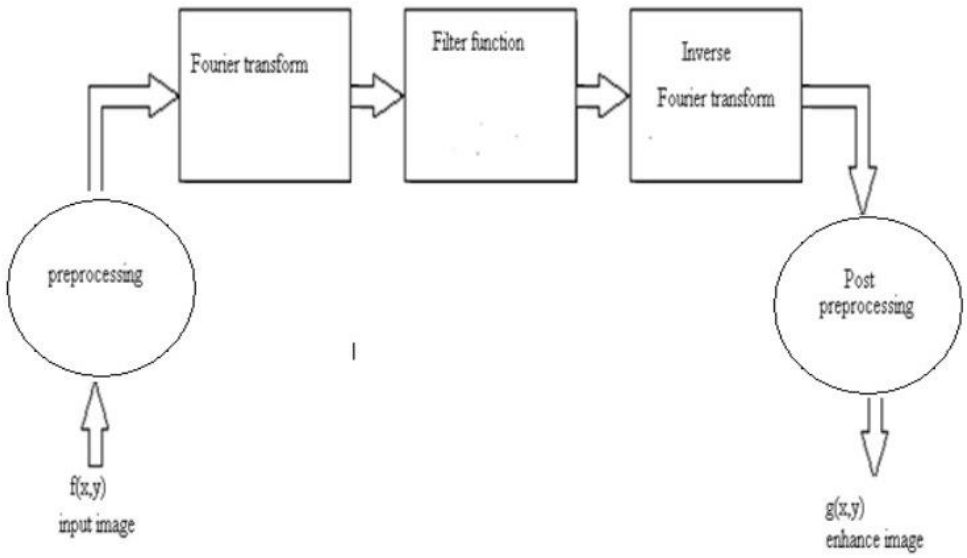


Figure 2.2: Basic steps for Frequency Domain

2.1.3. Fuzzy Domain:

Fuzzy set hypothesis is therefore valuable in taking care of different vulnerabilities in PC vision and picture preparing applications. Fluffy picture preparing is a gathering of distinctive fluffy ways to deal with picture handling that can comprehend, speak to, and process the picture. It has three principle stages, to be specific picture fuzzification, alteration of participation capacity qualities, and defuzzification. Fluffy picture upgrade is in view of dim level mapping into enrollment capacity. The fact is to make a photo of higher unpredictability than the first picture by giving a greater weight to the dull levels that are closer to the mean faint level of the photo that are more far off from the mean.

2.2. Fuzzy Set:

In set theory, a set is characterized as a gathering of components having a certain property, each of has a place with the set. So the trademark capacity takes either the estimation of 0 or 1.

Give us a chance to consider a set X called the space, whose components are meant as x,

i.e $X = \{x_1, x_2, x_3, ...x_n\}$. Choose a subset A of the set X such that a component x of X is an member from A if

$$\mu_A(x) = 1 \text{ if } x \grave{o} A$$

$$\mu_A(x) = 0 \quad \text{Otherwise}$$

So fuzzy set A is shown as:

$$A = \{(x, \mu_A(x)) : x \grave{o} X\}$$

Where $\mu_A(x)$ is a member function for a fuzzy set. Examples of membership functions are triangular, trapezoidal, Gaussian can be understood in figure and labelled with the following formulas:

2.2.1. Triangular membership function:

Triangular membership function is shown as a following equation:

$$\text{Triangular}(x; a, b, c) = \begin{cases} 0 & \text{if } x,, a \\ \dfrac{x-a}{b-a} & \text{if } a \le x \le b \\ \dfrac{c-x}{c-b} & \text{if } b \le x \le c \\ 0 & \text{if } c \le x \end{cases}$$

2.2.2. Trapezoidal membership function:

Trapezoidal membership function is defined as a following equation:

$$\text{Trapezoidal}(x; a, b, c, d) = \begin{cases} 0 & \text{if } x,, a \\ \dfrac{x-a}{b-a} & \text{if } a \le x \le b \\ 1 & \text{if } b \le x \le c \\ \dfrac{d-x}{d-c} & \text{if } c \le x \le d \\ 0 & \text{if } d \le x \end{cases}$$

2.2.3. Gaussian membership function:

Gaussian membership function is defined as following equation:

$$\text{Gaussian}(x; m, \sigma) = e^{-\left(\frac{(x-m)^2}{2\sigma^2}\right)}$$

where m = mean, and σ is the standard deviation.

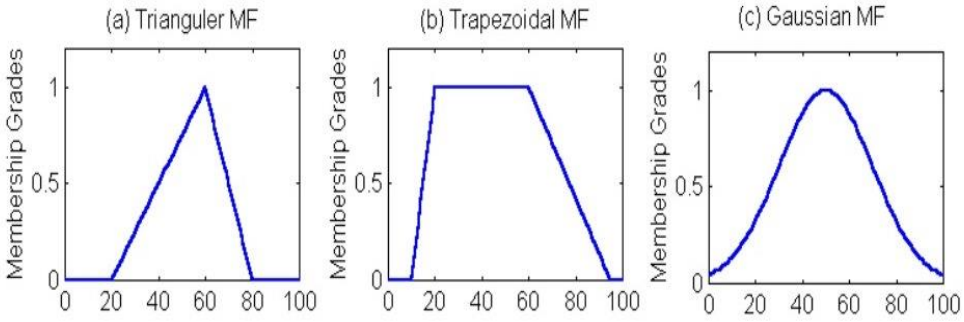


Figure 2.3: Examples of Membership Function

2.3. Fuzzy Inference System:

Fuzzy frameworks are made of a learning base and thinking component called fluffy deduction framework. A fluffy surmising framework (FIS) comprises of four practical squares as indicated in figure.

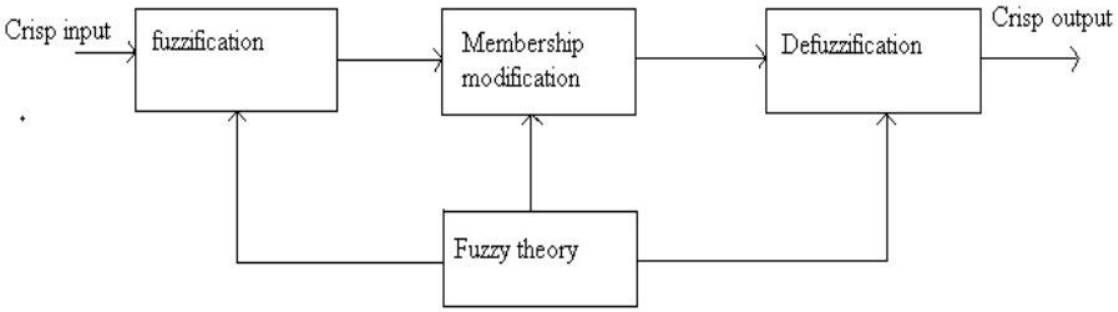


Figure 2.4: Fuzzy Inference System

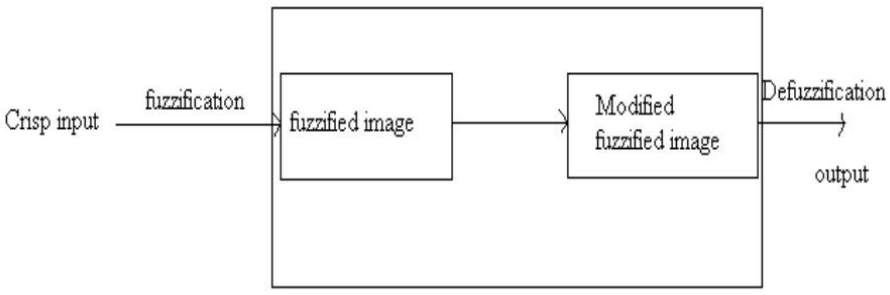


Figure 2.5: Membership Function Modification

Fuzzification: Changes the crisp inputs into degrees of match with phonetic qualities. Converse procedure ofdefuzzification.

Knowledge Base: Consists of a tenet base and a database. A tenet base contains various fluffy if-then guidelines. A database characterizes the enrollment capacity of the sets utilized as a part of the fluffy guidelines

Fuzzy Inference Engine: Fuzzy Inference engine achieves the implication operations on the instructions.

Defuzzification: This change of fuzzy set to particular crisp value is called defuzzification.

2.4. Fuzzy Image Processing:

Fuzzy image processing is accumulation of all methodologies that comprehend, speaks to and process the pictures, their sections and elements as fluffy sets. The demonstration and handling rely on upon the chose fuzzy system and the issue to been comprehended.

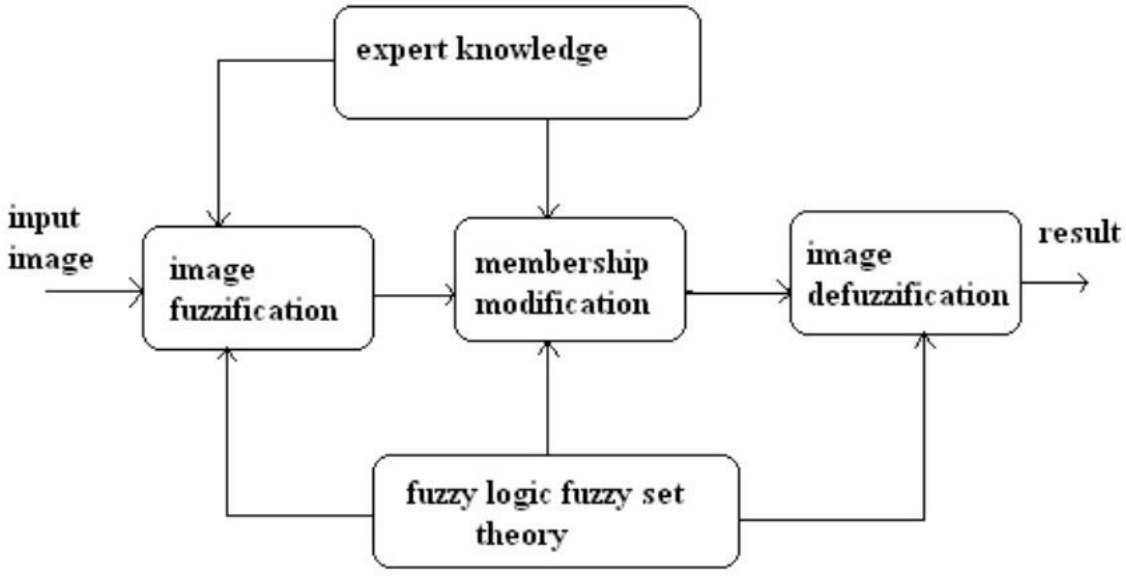


Figure 2.6: Fuzzy Image Processing

The defuzzificationand fuzzificationstages are because of the way that we don't have fluffy equipment. In this way, the coding of picture information (fuzzification) and deciphering of the outcome (defuzzification) stages that make conceivable to develop pictures with fluffy methods. The principle force of fluffy picture preparing is in the center step (enrollment adjustment).

Motivation behind fuzzy image processing:

To do this there are many reasons:

1. Fuzzy is effective device to information representation and procedure human learning in type of fluffy if then standards.
2. Fuzzy methods can deal with the vagueness proficiently and ambiguity (a picture can be spoken to as a fluffy set).

Observations about the fuzzy techniques are:

1. Fuzzy rationale is adaptable. With any given framework, its anything but difficult to oversee it or coatingadditional usefulness on upper of it without beginning again sans preparation.
2. Fuzzy logic is adroitly straightforward. The scientific ideas driving fluffy thinking are extremely straightforward.
3. Fuzzy rationale can be mixed with routine control methods. Fluffy frameworks don't essentially supplant ordinary control routines. As a rule fluffy framework enlarge them and streamline their execution.
4. Fuzzy rationale is taking into account normal dialect. The premise for fluffy rationale is the premise for human correspondence. This perception supports a number of alternate proclamations about fluffy rationale.
5. Fuzzy logic can display nonlinear elements of self-assertive multifaceted nature.
6. Fuzzy logic can be based on top of the experience of specialists.

Chapter 3

Literature Review

The work has done in the arena of image enhancement. In this segment, Area of work done of the image enhancement and fuzzy set is focus has been made on improve the quality of image.

3.1. Survey on Image Enhancement(IE):

Image enhancement changes a picture to makes its importance clearer to human onlookers. It is frequently used to expand the complexity in pictures that are significantly dull or light. Upgrade calculations regularly play thoughtfulness regarding human's affectability to differentiation. The primary goal of picture upgrade is to develop the picture so that the outcome is efficient than the first image. Image enhancement procedures such as map each grey level into another grey level by predetermined transformation, contrast stretching.

IE has wide applications in some of the areas noted below:

1. Face recognition, IE methods when connected to pictures and features help the outwardly disabled in perusing little print, utilizing PCs, TV and face acknowledgment. A few studies have been led that highlight the need and benefit of utilizing IE for the outwardly hindered.
2. Virtual reclamation of notable canvases and antiques regularly utilizes the strategies of IE keeping in mind the end goal to decrease stains and cleft. Shading differentiation improvement, honing and lighting up are only a percentage of the procedures used to make the pictures clear. IE is an effective instrument for restorers who can settle on educated choices by review the aftereffects of restoring a composition already. It is just as valuable in recognizing content from exhausted noteworthy records.
3. In the field of e-adapting, IE is utilized to clear up the substance of blackboard as saw on spilled feature, it enhances the substance intelligibility and helps understudies in

concentrating on the content Similarly, joint effort through the whiteboard is encouraged by upgrading the common information and lessening curios like shadows and flaws.

4. Medical imaging uses IE systems for lessening clamor and honing subtle elements to enhance the visual representation of the picture. Since moment points of interest assume a discriminating part in conclusion and behaviour of ailment, it is vital to best part essential components while showing medicinal pictures. This makes IE an important helping instrument for survey anatomic ranges in MRI, ultrasound and x-beams to give some examples.
5. Other fields counting law implementation, microbiology, biomedicine, bacteriology, climatology, meteorology, and so on., advantage from different IE strategies. These advantages are not constrained to expert studies and organizations but rather stretch out to the basic clients who utilize IE to cosmetically upgrade and right their.Survey on Fuzzy Set:

Despite the fact that fuzzy sets were presented in their cutting edge shape by Zadeh in 1965, the thought of a multi-esteemed rationale so as to manage dubiousness has been around from the earliest starting point of the century. Fuzzy sets give intends to model the instability connected with ambiguity, imprecision, and absence of data in regards to an issue. Peirce was one of the first scholars to genuinely consider dubiousness; he didn't put stock in the partition in the middle of genuine and wrong and thought all in life is a continum. In 1905 he expressed: “I have worked out the logic of vagueness with something like completeness”. Different acclaimed researchers and logicians tested this theme additionally. Russell guaranteed, “All language is vague” and pass onfurture saying; “vagueness is a matter of degree”.

Fuzzy set hypothesis sums up traditional set hypothesis in that the enrollment level of an article to a set is not confined to the whole numbers 0 and 1, but rather may tackle any worth in [0,1]. The fluffy hypothesis gives a component to speaking to phonetic builds, for example, “many,” “low,” “medium,” “often,” “few”. By and large, the fluffy rationale gives a

derivation structure that empowers fitting human thinking abilities. By explaining on the thought of fluffy sets and fluffy relations we can characterize fluffy rationale frameworks (FLS). FLSs are principle constructed frameworks, which a data is first fuzzifier and therefore handled by a derivation motor that recovers information as fuzzy tenets confined in a guideline base. The fluffy sets registered by the fluffy deduction as the yield of every guideline are then formed and defuzzified. A fuzzy logic framework is a nonlinear mapping from the data to the yield space.

The if-then rules in FL will combine with an inference engine to be more flexible. From the official web page of fuzzy tech, we find that the fuzzy logic technology has very good results in two main applications fields, which consists of industrial applications and business and finance applications. Those fuzzy logic applications can categorize under automated control or decision-making support.

3.2. Survey on Image Enhancement and Fuzzy Set:

Here the detail of work has been done on image enhancement and fuzzy set field is given:

In 1991 J.S. Kim, H.S. Cho and S.K. Kim used to fuzzy tenet based improvement calculation for uproarious picture. In contrast to the classical approach , the fuzzy approach makes use improve the quality of image. A new edge moderationprocedure that enhances the noisy border information's in image. The algorithm employs reductionprocedure that reduces or even removes of derived operator answer via contextual information. The appropriate information's are the neighborhoods patters of a fundamental edge which are projected using the fuzzy pattern similarmethods.

In 2008 Dr.Prashant R. Deshmukh, Milindkumar V. Sarode, Dr. S.A. Ladhake,worked fuzzy framework for shading picture upgrade. This paper includes the utilization of learning base framework that are fit for copying the conduct of a human master. Fuzzy methodology of knowing seriousness of tumor is crucial to figure out whether there is a requirement for the biopsy and it provides for client a reasonable thought of spread and seriousness level of tumor. Fuzzy based upgrade of shading component of tumor is a use of fuzzy in the zone of

shading element extraction for improvement of a curious component. It has been found that RGB shading model is not suitable for improvement on the grounds that the shading parts are not decoupled. Then again, in HSV shading model, hue(H), the shading substance is partitioned from immersion (S), which can be utilized to weaken the shading substance and V, the power of the shading substance. By saving H, and changing just S and V, it is conceivable to upgrade shading picture. Hence, we have to change over RGB into HSV for the reason. A Gaussian sort participation capacity is utilized to model S and V property of the picture. This participation capacity utilizes one and only fuzzifier and is assessed by boosting fuzzy difference. Our point is be to dissect and improve the components identified with a particular sickness.

The biomedical pictures will be sent for fuzzification and choices identified with arrangement of hues will be done and likewise yield will be comprising of just the genuine tumor district and loud pixels will be separated and picture will be upgraded in the elements we fancy. Fluffy rationale addresses such application splendidly as it takes after human choice making with a capacity to produce exact arrangements from certain or estimated data. It fills an imperative hole in designing configuration techniques left empty by simply scientific methodologies and absolutely rationale based methodologies in framework plan.

In later 2009 SasiGopalan, Madhu S Nair and Souriar Sebastian Cochin University of Science and Technology (CUSAT), worked an estimate Studies on Image Enhancement using Fuzzy method and fuzzy entropy measuring the image which increases the sharpness of its argument image decreases and uses three factorsthey are intensification parameter,fuzzifier and crossover point. It considered five different types of images and enhanced an image.

In later 2009 Mr. Harish Kundra, Er.Aashima, Er. Monika Verma worked Image Enhancement Established on Fuzzy Logic in this paper a channel is presented which will evacuate the commotion and enhance the complexity of the picture. To accomplish this objective fluffy rationale control based methodology is utilized. The channel is tried on the hued pictures.

Chapter 4

Problem Statement and Methodology

4.1. Problem Statement:

In today's world many techniques are used for image enhancement. But fuzzy is the most popular and modern technology for image enhancement. An image that contain high differentiation and all around characterized edges and valleys are called as great quality picture, while a low quality picture is stamped by low complexity and poorly characterized limits between the edges.The focal objective of the work is to applianceanprocedure based on double threshold, otsu's and fuzzy for image enhancement. In literature survey the existed methods are able to enhance gray scale images. But depending on application they designed the enhancement method is different for different type of images.

The objective of the thesis work contains the following steps as described below:

1. To study the concept of enhancement and fuzzy set.
2. To study of various existed image enhancement techniques by using MATLAB.
3. Study of existed fuzzy techniques for image enhancement.
4. To propose an algorithm to enhance the poor quality image to good quality images by increase the contrast.
5. Implement a fuzzy algorithm in MATLAB.

4.2. Methodology:

The step-by-step procedure for image enhancement using fuzzy theory:

1. Analyze and Studyseveral image enhancement methods and fuzzy methods.
2. Based upon analysis algorithm is established for image enhancement by consuming MATLAB R2010a version.
3. Results accomplished after the implementation of program are equated with the previous outputs.

Chapter 5

Simulation Results and Discussion

5.1. Contrast Enhancement based on Double Threshold T2, T3:

The subdivision linear conversionwouldmodify the factors a, a', b, b', c, c', d, d'. The modification course is significant require some investment. The accommodate effect is not intuitionistic when modify these parameters. After Double breaking point division, the subsection straight change is moved forward. As indicated in underneath figure.

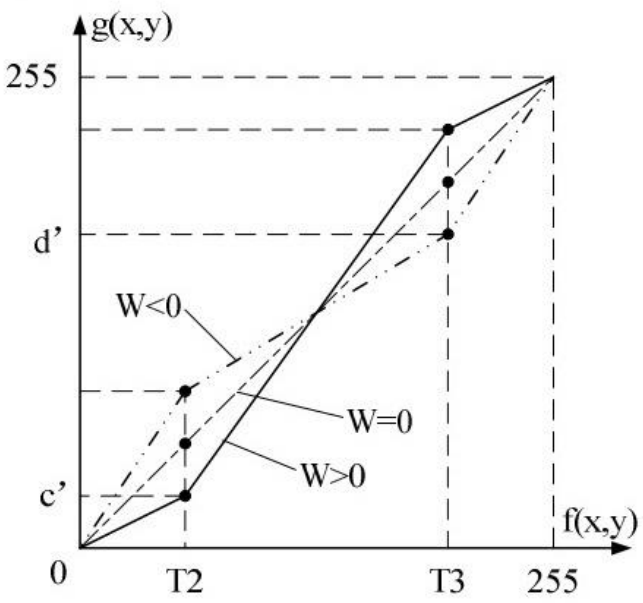


Figure 5.1: Transformation built on double-threshold segmentation

The understanding steps of anprocedure as follows:

1. Step 1: a=a'=0,b=b'=255. It makes the grayschange from 0 to 255 and not be shortened.
2. Step 2:c=T2, d=T3. This makes the c and d a finest value.
3. Step 3: $c' = T2(1-w)$, $-1 \le w \le 1$ and c'< T3.
4. Step 4: d'=T3+ $w(255-T3)$, $-1 \le w \le 1$ and T2< d'< 255.

Transformation formula is as follow:

$$g(x,y)=\begin{cases}(1-w)\times f(x,y) \\ T2(1-w)+\left(\dfrac{255+(1-w)(T3-T2-255)}{T3-T2}\right)(f(x,y)-T2) \\ 255w+(1-w)\times f(x,y)\end{cases}$$

After we getting the threshold T3 and T2 by double threshold segmentation, the enhancement can be understood easily bychanging the weight factor w.

When weight factor is greater than 0, it compress the both ends and stretch the middle part.The continuous line of fig.tells the enhancement arc.

When weight factor is less than 0, it stretch the both ends and compress the middle part. The double dot dash line of fig. tells the contrast enhancement arc.

When weight factor equal to 0. Here, the output image equal to input image.The dot dash line of fig.tells the enhancement arc.

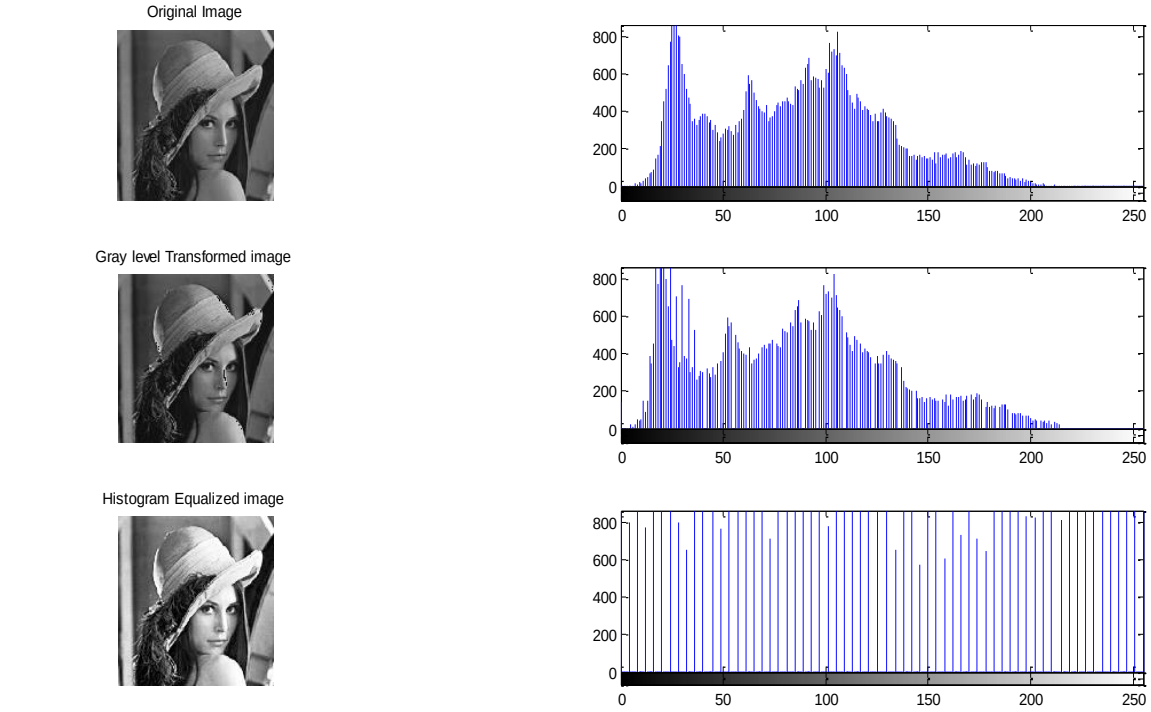


Figure 5.2: Lena Histogram Equalized Image

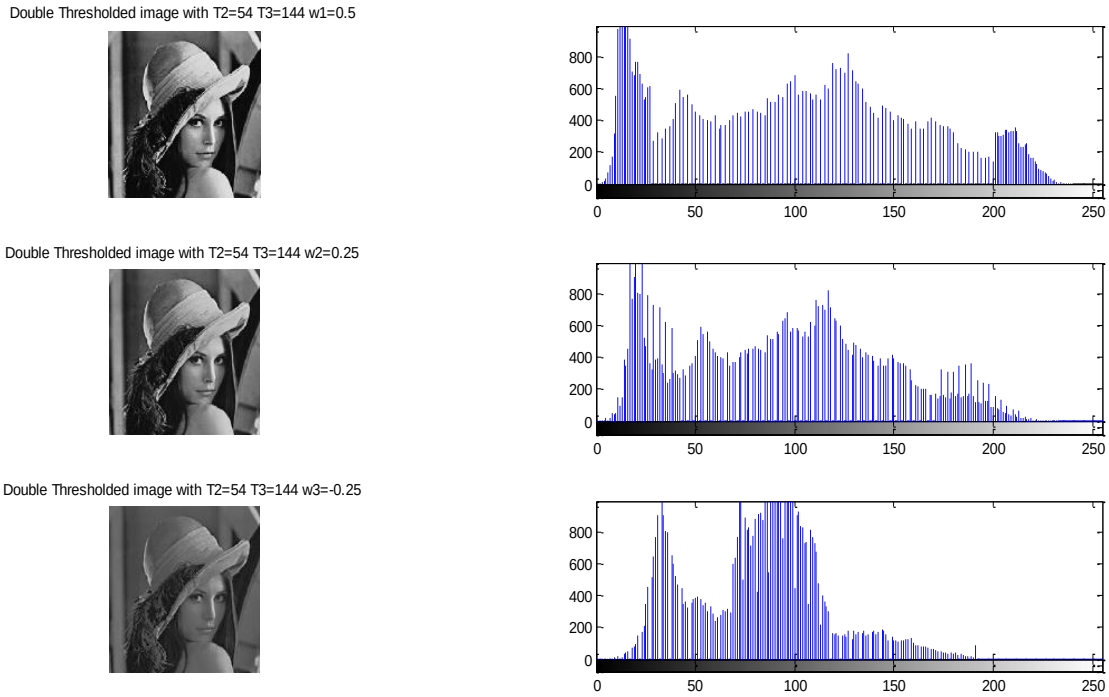


Figure 5.3: Lena Double-threshold Enhanced Image

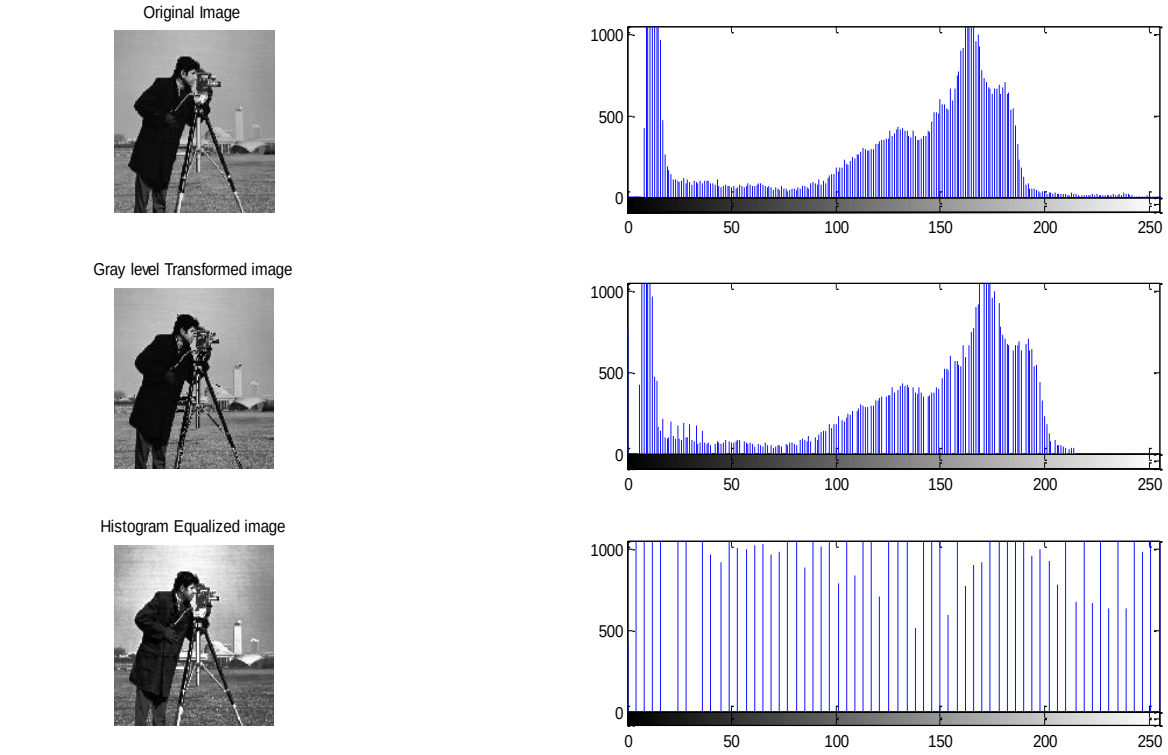


Figure 5.4: Cameraman Histogram Equalized Image

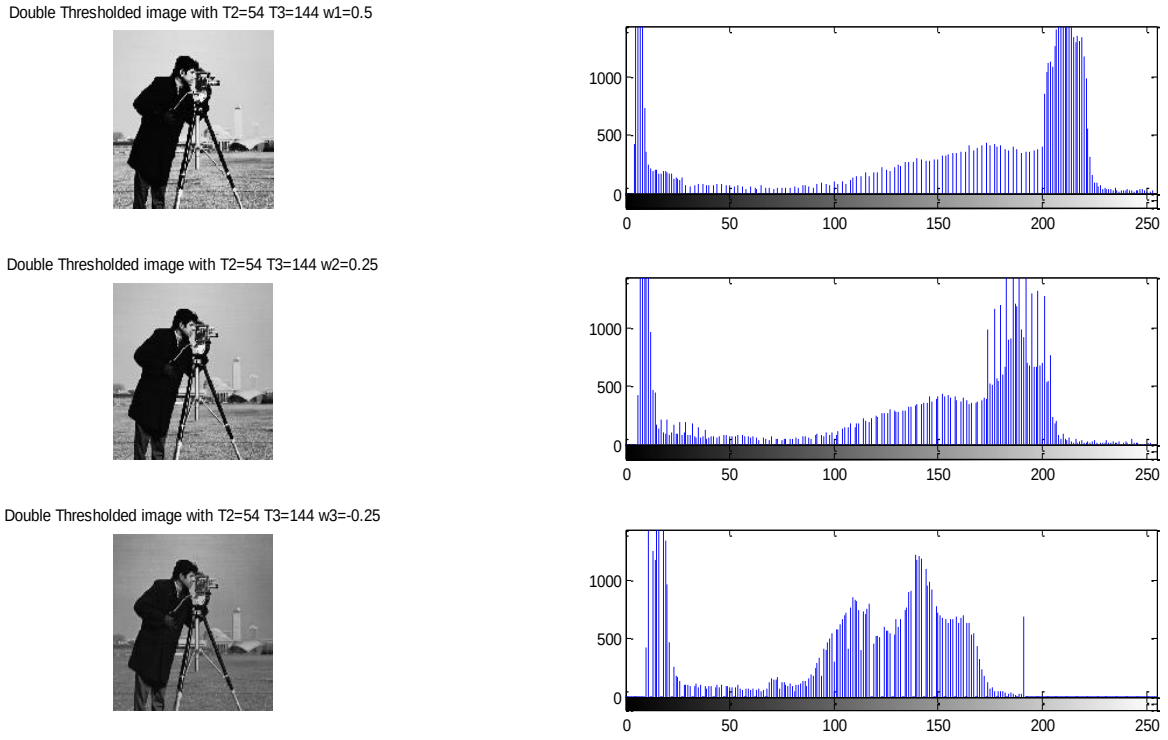


Figure 5.5: Cameraman Double-threshold Enhanced Image

5.2. Enhancement based on Otsu's Method:

In image processing, Otsu's technique is used to mechanicallydogroupingconstructed image thresholding or Binary image discount of grey level image .The calculation accept that the picture contains two classes of pixels. i.e.,Back Ground pixels and Fore ground pixels it then computes the optimalthresholdingsplitting the two classes.

Otsu's processis the most successful method for image thresholding. The augmentation of the this strategy to multi-level thresholding alluded to as the Multi Otsu method.

In Otsu's technique, we comprehensively hunt down the edge that minimizes the intra class difference (the fluctuation inside of the class) characterized as a weighted whole of changes of two programs.

$$\sigma_w^2(t) = w_1(t)\sigma_1^2(t) + w_2(t)\sigma_2^2(t)$$

Where the class probabilities are estimated as:

$$w_1(t) = \sum_{i=1}^{t} P(i) \quad w_2(t) = \sum_{i=t+1}^{I} P(i)$$

The individual class variances are:

$$\sigma_1^2(t) = \sum_{i=1}^{t} \left[i - \mu_1(t) \right]^2 \frac{P(i)}{q_1(t)} \quad \sigma_2^2(t) = \sum_{i=t+1}^{I} \left[i - \mu_2(t) \right]^2 \frac{P(i)}{q_2(t)}$$

Weights w_i are the possibilities of two curriculumsdivided by a threshold and σ_i^2 differences of these periods.

Otsu demonstrates that reducing that intra-class difference is the similar as boosting inter-class difference.

$$\sigma_b^2 = \sigma^2 - \sigma_w^2(t) = w_1(t)\,w_2(t)\left[\mu_1(t) - \mu_2(t)\right]^2$$

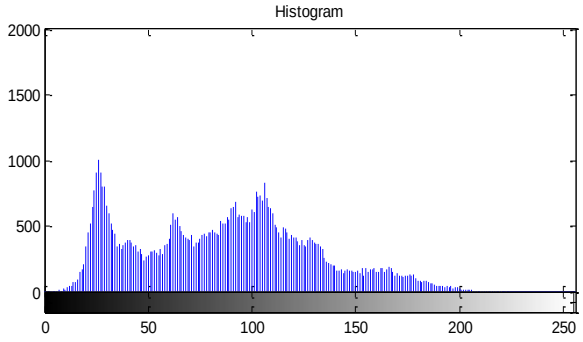
This is expresses in terms of class probabilities and class means μ_i

The class means are given by:

$$\mu_1(t) = \sum_{i=1}^{t} \frac{iP(i)}{q_1(t)} \quad \mu_2(t) = \sum_{i=t+1}^{I} \frac{iP(i)}{q_2(t)}$$

Otsu's Algorithm:

1. Calculate histogram and possibilities of every intensity level.
2. Fixed up first $w_i(0)$ and $\mu_i(0)$.
3. Stageover all imaginablethresholds t=1. . . . .Extreme intensity.
    1. Modernize w_i and μ_i.
    2. Calculate $\sigma_b^2(t)$.
4. After calculating the all variance the index at which we get the maximum variance value, we use that intensity as a required threshold value.
5. Desired threshold corresponds to the maximum $\sigma_b^2(t)$.



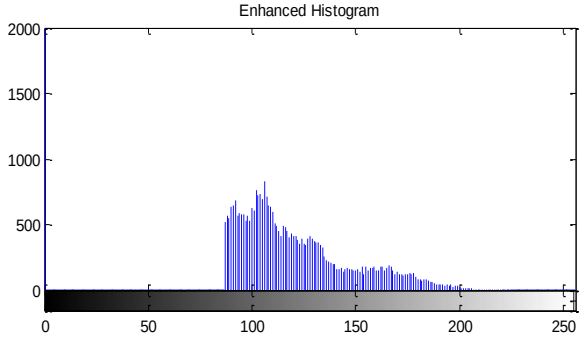


Figure 5.6: Otsus's Enhanced Lena Image

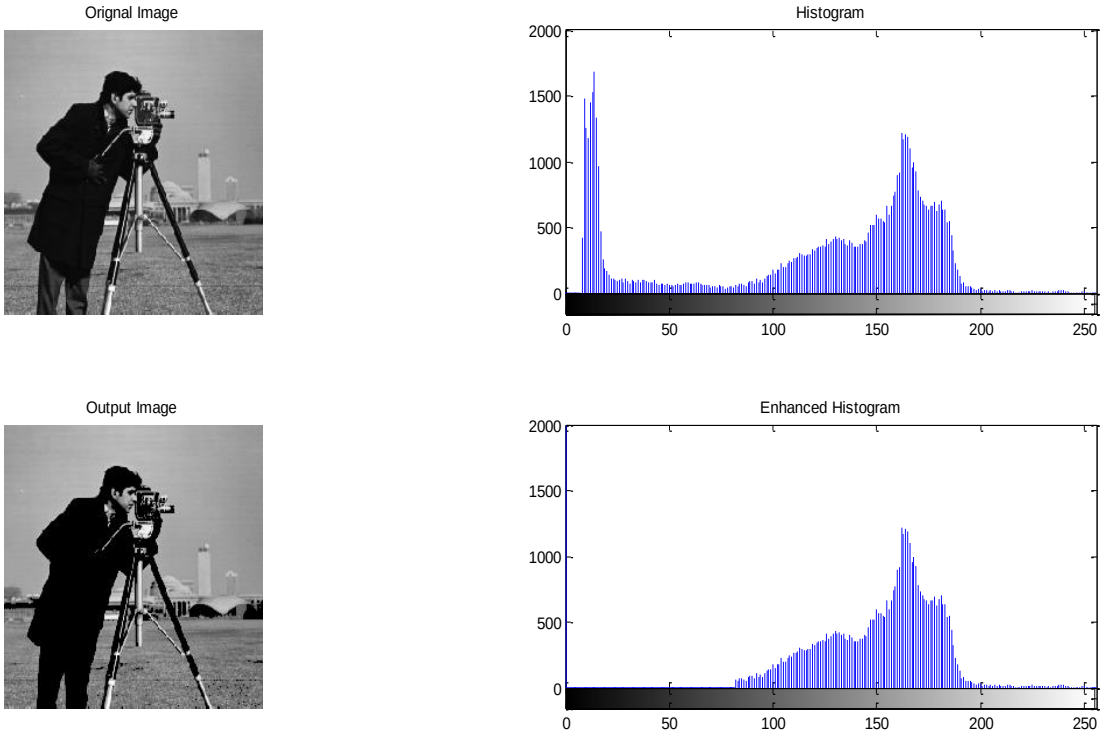


Figure 5.7: Otsus's Enhanced Cameraman Image

5.3. Contrast Enhancement based on Fuzzy:

I have developed the methodology for the improvement of color images using fuzzy. In fuzzy methodology, approximate pixel property like dark quality or shading intensity, is displayed into a fuzzy set utilizing a participation capacity.

Fuzzy based picture upgrade technique is displayed by fuzzifying the colour force property of the picture utilizingGaussian function.

The three keycharacteristics used to differentiate one colour from alternative areSaturation, Intensity (HSV) and Hue, and this model is decided for the plannedto improvement system. A gaussian type membership capacity is exploited to model V things of the picture.

A Model V property is used by Gaussian type membership function of the image:

$$\mu_X(x) = e^{\left[-(x_{max}-x)^2/2 f_h^2\right]}$$

Average fuzzy contrast and Fuzzy contrast of original image:

$$C_{fo} = \frac{1}{L}\sum_{x=0}^{L-1}\left[\mu_X(x) - \mu_c\right]^2 p(x)$$

$$C_{afo} = \frac{1}{L}\sum_{x=0}^{L-1}\left[\mu_X(x) - \mu_c\right] p(x)$$

Theoriginal image quality is given by:

$$Q_{fo} = \frac{\left|C_{afo}\right|}{C_{fo}}$$

A parametric sigmoid function given by:

$$\mu'_X(x) = \frac{1}{\left(1 + e^{-t(\mu_X(x) - \mu_c)}\right)}$$

$\mu'_X(x)$=Modified membership function.

Average fuzzy contrast and Fuzzy contrast of an image:

$$C_f = \frac{1}{L}\sum_{x=0}^{L-1}\left[\mu'_X(x) - \mu_c\right]^2 p(x)$$

$$C_{af} = \frac{1}{L}\sum_{x=0}^{L-1}\left[\mu'_X(x) - \mu_c\right] p(x)$$

Quality Factor of an image is known as the ratio of absolute average fuzzy contrast to fuzzy contrast:

$$Q_f = \frac{\left|C_{af}\right|}{C_f}$$

Fuzzy optimization using entropy:

$$E = \frac{-1}{Lln2}\sum_{x=0}^{L-1}\left[\mu'_X(x) ln\left(\mu'_X(x)\right) + \left(1 - \mu'_X(x)\right) ln\left(1 - \mu'_X(x)\right)\right] p(x)$$

E is aamount of excellence of info in an image in fuzzy field.

$$f_h^2 = \frac{1}{2}\frac{\sum_{x=0}^{L-1}(x_{max} - x)^4 p(x)}{\sum_{x=0}^{L-1}(x_{max} - x)^2 p(x)} \quad t = -\frac{E_t}{E_c Q_e}$$

Entropy-based average fuzzy contrast and Entropy-based fuzzy contrast given by:

$$C_{fe} = \frac{1}{L}\sum_{x=0}^{L-1}\left[\left(\mu_X(x) - \mu_c\right)^2 g(\mu')\right]p(x)$$

$$C_{afe} = \frac{1}{L}\sum_{x=0}^{L-1}\left[\left(\mu_X(x) - \mu_c\right) g(\mu')\right]p(x)$$

Quality Factor of Entropy-based image is:

$$Q_e = \frac{\left|C_{afe}\right|}{C_{fe}}$$

The Image quality change is given by:

$$Q_{ne} = \frac{Q_e - Q_{fo}}{Q_{fo}}$$

Fuzzy to spatial domain Inverse operator is given as:

$$x' = x_{max} - \left(-2ln\left[\mu'_X(x)\right] f_h^2\right)^{1/2}$$

Visual factor:

$$v_f = \frac{Q_e}{Q_{fo}}$$

Algorithm:

1. Take the colour image and transform RGB to HSV.
2. Compute Histogram $p(x)$where xòV .
3. Compute the early f_h .
4. Fuzzify V to known $\mu_X(x)$.
5. Initialize $\mu_c \leftarrow 0.5$, and compute C_{afo}, C_{fo}, Q_{fo}.
6. Initialize $t \leftarrow 5$, and select a desired factor Q_{fd} = 0.4 to study the factors (t, μ_c, f_h) repeatedly.
7. Enhance the impartialpurpose using the ImprovedUnivariatetechnique and no. of repetitions, $N \leftarrow 300$.
8. Adjust the participation capacity with enhanced parameters (t, μ_c, f_h).
9. Defuzzify V for the improved value. Show the Enhanced HSV image.

Figure 5.8: Fuzzy Enhancement Image(Office)

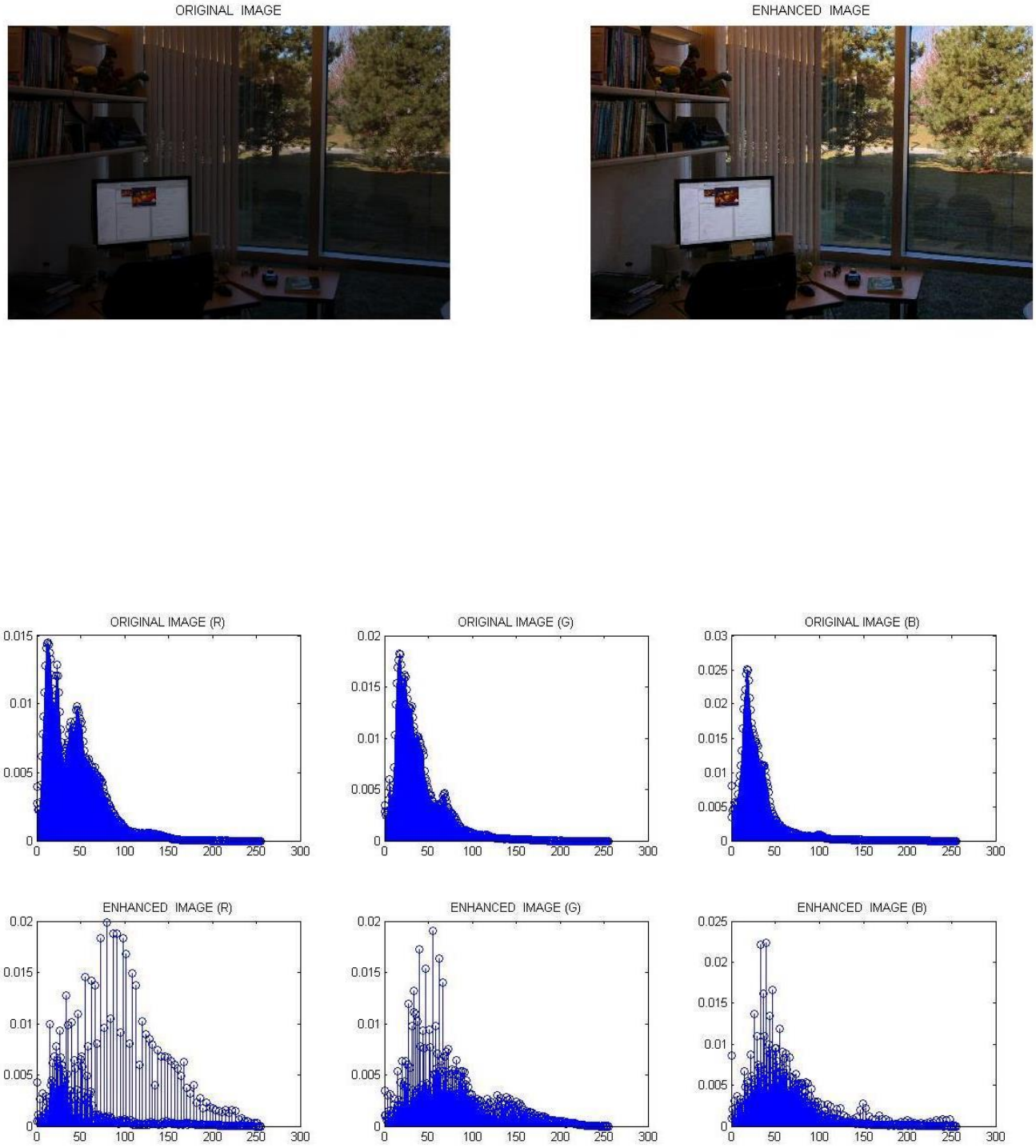


Figure 5.9: Fuzzy Enhancement Histogram

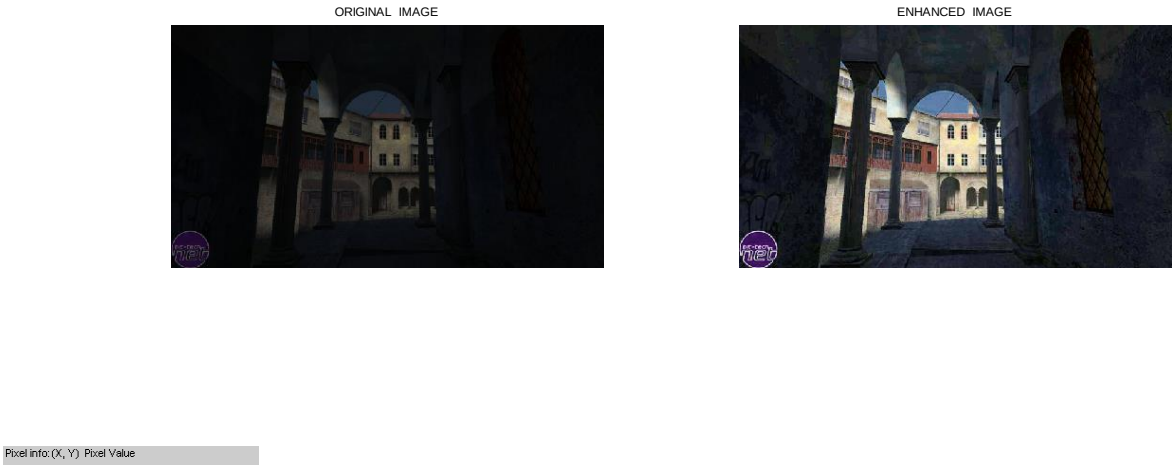


Figure 5.10: Fuzzy Enhancement Image(Building)

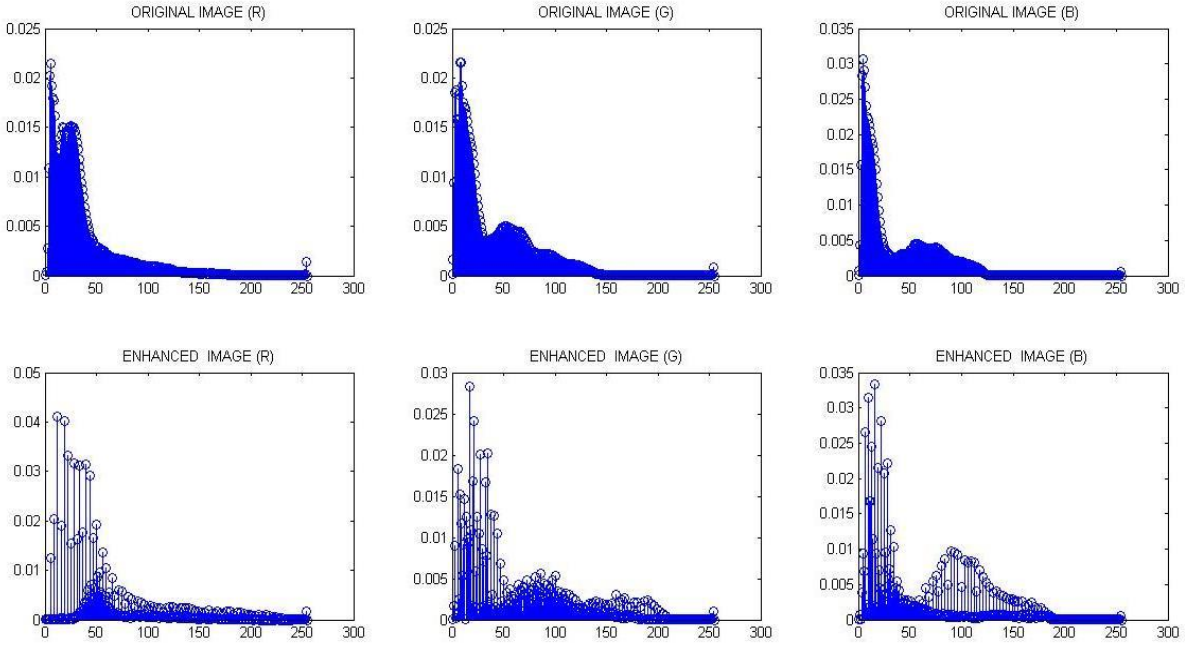


Figure 5.11: Fuzzy Enhancement Histogram

INITIAL PARAMETERS OF ORIGINAL IMAGES

Images	E	f_h	T	μ_c	Q_{fo}
Building	0.5423	73.2243	5.00	0.50	1.4561
Hotel	0.6753	90.0829	5.00	0.50	2.1684
Office_1	0.7481	87.0040	5.00	0.50	1.9461
Office_2	0.6124	95.1461	5.00	0.50	1.7195
Hall	0.7874	121.592	5.00	0.50	1.8250

OPTIMIZATION OF E with Q_{fd} =0.4 (ENHANCED IMAGE)

Images	E	f_h	T	μ_c	Q_f	v_f
Building	0.4835	74.5684	6.00	0.44	0.9124	0.865
Hotel	0.5383	88.1725	7.15	0.45	1.2241	0.845
Office_1	0.5934	86.6518	7.00	0.45	1.3548	0.912
Office_2	0.5662	94.0581	7.50	0.50	1.2519	0.952
Hall	0.6754	115.183	8.15	0.46	1.5452	1.225

Chapter 6

Conclusion and Future Direction

6.1. Conclusion:

The principle center of this research is on image enhancement using different image enhancement techniques. Experiment was done first on low quality image and compared to the resulted image. A double threshold segmenation is planned for contrast enhancment. Threshold splits the image as transition, object, backgroundZones. It improve the image disparity bystretching or compressingsure image zone and this correct effect is by altering the weight factor w. In present-days, variousinvestigators have applied the fuzzy logic to expand image processing procedures. The fuzzy image processing is one of the significant application parts of fuzzy logic.

In this work one membership function is defined to enhance the image and algorithm is proposed. The algorithm is implemented in MATLAB R2010a and this is able to overwhelmed the drawbacks of spatial domain approaches like, histogram equalization thresholdingetc., This fuzzy algorithm is able to get good contrast image which increases the brightness of the under exposed contrasted images. This algorithm is tested on different types of images. The Simulation result shows that the brightness is increased as compared to previous one. Image enhancement by fuzzy is the finest compared to other algorithms.

6.2. Future Direction

Future work can be extended for other images to obtain better result with accuracy. In future alteration of the algorithm can yield the improved result for the image. The improved result for image enhancement has also used in real time enhancement of neuroevalution of supplementing. Image enhancement methods used in numerous areas such as Fingerprint matching, Forensics and Astrophotography etc.

REFERENCES

1. Zhang Y.J,"Improving the accuracy of direct histogram specification", IEE Electronics letter., 1992, 28: pp. 213-214.
2. Alex Stark J,"Adaptive image contrast enhancement using generalizations of histogram equalization", IEEE Transactions on Image processing., Vol. 9, no. 5,: pp. 889-896, 2002.
3. Zuquan Xiang, Z. Liu, X. Zou, Z. Liu, "A contrast enhancement algorithm based on double-threshold segmentation for LCD controller", 3rd International Congress on Image and Signal Processing(CISP)., vol. 5, pp. 2434-2437, 2010.
4. M. Hanumandlu, D. Jha, "An optimal fuzzy system for color image enhancement," IEEE Trans. Image Process., vol. 15, no. 10, pp. 2956-2966, Oct. 2006.
5. Otsu N, "A threshold selection method from gray level histogram", IEEE Transactions on Systems, Man, and Cybernetics., Vol. SMC- 9, No.1 : pp. 62-66, 1979.
6. Dah-Chung Chang, Wen-Rong W,"Image Contrast Enhancement Based on a Histogram Transformation of Local Standard Deviation", IEEE Transactions on Medical Imaging., Vol. 17, no. 4, pp. 518 – 531, 1998.

7. S.S.Reddi, S.F.Rudin, H.R.Keshavan, “An optimal multiple threshold scheme for image segmentation,” IEEE Trans. System Man Cybernet., Vol. 14, no. 4: pp. 661-665, 1984.
8. Y.S.Choi and R.Krishnapuram, “A robust approach to image enhancement based on fuzzy logic,” IEEE Trans. Image Process., vol. 6, no. 6, pp. 808-825, june. 1997.
9. M.Hanmandlu, M.Jha, and R.Sharma, “Color image enhancement using fuzzification,” pattern Recognit. Lett., Vol. 24, no. 1-3,: pp. 81-87, 2003.
10. P.Mukherjee and B.N.Chatterji, “Note:Adaptiveneighborhood extended contrast enhancement and its modifications,” Graph. Models Image Process., vol. 57, no. 3, pp. 254-265, 1995.
11. Y.S.Choi and R.Krishnapuram, “A robust approach to image enhancement based on fuzzy logic,” IEEE Trans. Image Process., vol. 6, no. 6, pp. 808-825, june. 1997.
12. Jain, Anil.K,“Fundamentals of digital image processing”.
13. Gonzales, R.C., Woods, R.E.: ‘Digital image processing’ (Addison Wesley, Reading, MA, 1992).
14. R. Gonzalez, R. Woods and S. Eddins “Digital Image Processing Using Matlab”, 2004, Prentice Hall.